Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

These were, of course, condensed in the arrangement, all the page references to a given name being placed under a single entry so that the printed result is much curtailed.

During the first five years of the academy's life it maintained a sort of chrysalis existence without much communication with the outside world. Of the six men who attended the initial meeting but one, the Dutchman Gerard Troost, later elected the first president, had any scientific training. At the next meeting Thomas Say was "adopted" by the others as one of the founders and he has since been regarded as one of the seven to whom the academy owes its existence. The communications to the meetings were at first confined almost solely to selections from Rees's Encyclopedia and certain text-books of science, but original observations soon became more frequent and by 1817 a sufficient amount of such material was in possession of the society to warrant the belief that an avenue of publication would be desirable. Through the interest and zeal of William Maclure, a Scotch philanthropist, the first number of the *Journal* was placed before the meeting held May 20, 1817. The volume contained contributions from Chas. A. Lesueur, Geo. Ord, Thomas Say, Thomas Nuttall, and William Maclure. Its interest and value were much enhanced by the beautiful engravings by Lesueur. It was at the time the only avenue of communication with the scientific world possessed by the working naturalists of America.

This series staggered on with intervals of quiescence until 1842, when it was decided that the *Proceedings*, which had been begun the previous year for the purpose of giving prompter publicity to the current business of the academy, supplied all that could be secured by an octavo publication.

To provide for papers requiring more elaborate illustrations than could be supplied in the octavo form, a quarto journal was started in 1847 and has been continued to the present time, the superb fifteenth volume having been published last December as the chief memento of the celebration held in March. Incidentally it may be mentioned that the prompt issue of that volume, within nine months of the event it records, has been regarded all over the world as a record-breaking achievement. The illustrations to the quarto series were from the first of a high order of artistic merit. Special mention may be made of the colored illustrations of Cassin's birds, supplied by the liberality of Thomas B. Wilson; the really beautiful lithographs by Ibbotson of Isaac Lea's Melanians and Unios; and more recently the superb chromoplates of prehistoric pottery furnished by Mr. Clarence B. Moore in illustration of his monographs.

Access to the scientific contents of the eighty-three volumes, constituting one of the most important agencies in the advancement of science, will be greatly facilitated by the issue of the index which will undoubtedly be highly valued by students.

A few pages are devoted to a record of the time of publication of the several parts and volumes. The minutes, correspondence, and accessions lists of the academy were consulted to determine as many such dates as possible, and it is to be regretted that the result is not complete, the requisite data not being at hand, after the most careful search, to make it so. As far as the record goes, however, it will establish dates of publication of many researches of the first importance and help to determine many questions of priority, a matter to which the working naturalist is apt to attach much more importance than do those who value results without caring greatly as to who attains them.

EDW. J. NOLAN

SPECIAL ARTICLES

FACTORS INFLUENCING THE SURVIVAL OF BACTERIA AT TEMPERATURES IN THE VICINITY OF THE FREEZING POINT OF WATER[1]

IT has been held by some bacteriologists that, while temperatures about the freezing point of water are less destructive of bacterial life than those about the boiling point, low temperatures are not only unfavorable to the growth and multiplication of bacteria, but

[1] Preliminary communication.

also to their prolonged existence. Prudden's experiments (1887) with water suspensions of a staphylococcus, in tubes greased to prevent crystallization at the temperatures employed (15–25° F.), led him to believe that at the same temperature the destruction of bacteria, due to cold, was greater when the water did not freeze, than when it did. Park, however, made similar experiments (1900) with *B. typhosus* and found that at the same temperature the reduction was 30 per cent. less in water remaining liquid for three days than where the water was frozen for the same length of time. Park further cites an experiment upon the freezing of typhoid bacilli in which 50 per cent. to 70 per cent. are killed "at the time," not more than 10 per cent. surviving after one week and 1 per cent. after four weeks, while Sedgwick and Winslow, after a careful review of the literature and many experiments, came to the conclusion that there is "during the first half hour of freezing a heavy reduction . . . amounting to perhaps 50 per cent. After this brief period of sudden but uncertain 'reduction' the destruction of the germs proceeds pretty regularly as a function of the time." Prescott and Winslow in their "Water Bacteriology" remark (p. 17) that "Temperature has a direct relation to bacterial life, and the number of parasitic bacteria at least may be quickly lessened by the action of cold." These conclusions are supported by the fact that ice, and especially old ice, even when formed from polluted sources, is very low in bacterial life.

On the other hand, it has gradually become known that various frozen foods, such as ice cream, frozen meat and frozen milk, often contain very large numbers of living bacteria, and this, too, even when kept for a long time, so that a serious contradiction seems here to exist between theory and fact. To this contradiction my attention was first drawn some two years ago during bacteriological studies of frozen eggs, and especially by the fact that such eggs, even after an exposure of many months to a temperature of 0° F., still contained millions of living bacteria. Obviously it was no longer possible to hold that either mere cold or time is in and of itself necessarily destructive of bacterial life; and in the hope of bringing theory more clearly into harmony with experience I have within the last year made numerous experiments calculated to throw further light upon the general behavior of bacteria at temperatures about the freezing point of water.

Thus far I have worked almost exclusively with a single species, *B. coli*, which, as is well known, thrives at various moderate temperatures and especially at the blood heat. I have employed chiefly a 24-hour agar growth suspended in water, in physiological salt solution, in various dilutions of fat-free milk, in various mixtures of pure glycerine and water, and in solutions of cane sugar and of commercial glucose. In some cases freezing was done directly in test tubes; in other cases in an ice cream freezer with the formation of an ice "mush" or magma. By the courtesy of the Quincy Market Cold Storage and Warehouse Company of Boston I have been able to hold the suspensions thus frozen at temperatures as low as zero F. for periods of from four to eight months. The experiments are still in progress and some of them may be extended over a term of years.

The following is a brief summary of results:

I. When *B. coli* are frozen in Boston tap water (in test tubes) as solid ice, and held at — 20° C., only a fraction of one per cent. of the original number remain alive at the end of five days. Storage of a few weeks results in complete destruction of the bacteria. These results confirm those of Sedgwick and Winslow.

II. When *B. coli* are frozen in Boston tap water not solidly, but as a water ice or sherbet is frozen, and held in this condition at — 20° C., a large percentage remain alive for many months.

III. When *B. coli* are frozen in milk, pure and diluted to various degrees with water, the death rate of *B. coli* increases with the dilution, the largest numbers surviving in the un-

diluted milk and the fewest in that containing the most water.

IV. When suspended in aqueous mixtures containing from 5 per cent. to 42 per cent. of chemically pure glycerin and held at — 20° C., a very large percentage of *B. coli* remain alive for at least six months.

V. At + 37° C., *B. coli* in water or in 5 per cent. to 20 per cent. glycerin[2] die rapidly, few if any remaining alive at the end of 72 hours. The death rate diminishes as the holding temperature is lowered, though it is still marked even just above 0° C.; but at a temperature slightly lower a sudden change appears, the death rate at and below that point being but little, if any, greater than at — 20° C.

VI. By covering a 24-hour growth on agar with a sterile 10 per cent. cane sugar solution, and holding at — 10° C., stock cultures of *B. subtilis, B. aurococcus, B. megaterium, B. fluorescens, B. proteus* and *Sarcina aurantiacus* have been kept in a vigorous condition (without transferring) for eight months.

From these results the following conclusions may be drawn:

Low temperatures alone do not destroy bacteria. On the contrary, they appear to favor bacterial longevity doubtless by diminishing destructive metabolism. Frozen food materials, such as ice cream, milk and egg substance, favor the existence of bacteria at low temperatures, not because they are foods, but apparently because they furnish physical conditions somehow protective of the bacteria.

It seems likely that water-bearing food materials as well as sugar solutions, glycerin solutions, etc., freeze in such a way that most of the bacteria present are extruded from the water crystals with other non-aqueous matters (including air) and lie in or among these matters without being crushed or otherwise injured; while in more purely watery suspensions, and, above all, in water itself in which the whole mass becomes solidly crystalline, they have no similar refuge but are perhaps caught and ultimately mechanically destroyed between the growing crystals. This theory would explain the absence of live bacteria in clear ice, their comparative abundance in "snow" ice and "bubbly" ice, and also the fact that the more watery food materials when frozen contain the fewest, and the least watery the most, living bacteria.

The comparatively rapid death of bacteria in non-nutrient materials at higher temperatures and their slower dying at lower temperatures agrees well with the theory of simple starvation or destructive metabolism. At the higher temperatures they perish quickly because they burn themselves out quickly; at the lower, more slowly, because they consume themselves more slowly. At temperatures where metabolism ceases altogether they continue to exist in a state of suspended vitality similar to that exhibited by many other and higher plants which in the far north are subjected without apparent injury for long periods to temperatures much below the freezing point of water.

S. C. KEITH, JR.
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

[2] Glycerine mixtures much exceeding 20 per cent., at temperatures above the freezing point of water, act as mild antiseptics. Under 20 per cent. this is not the case, the death of the bacteria apparently resulting from lack of food, as it does not occur when a small amount of peptone is present.

HEMOPHORIC FUNCTION OF THE THORACIC DUCT IN THE CHICK

IN a recent investigation of the development of the thoracic duct in the common fowl, the writer studied also certain aggregations of mesodermal cells correlated with the developing duct, and considered by Sala,[1] more than ten years ago, as "cords" of mesenchymal cells out of which were "hollowed" the rudiments of the duct.

The writer believes, and in the near future will publish evidence to substantiate the belief, that these aggregations of mesodermal (mesenchymal) cells comprise developing blood cells which are differentiated *in situ* out of the indifferent mesenchymal syncytium, that these blood cells then gain access to the lymph

[1] Sala, *Richerche fatta nel Lab. di Anat, Norm. della R. Univ. di Roma,* Vol. 7, 1900.